Name of Organization: Indiana University

Type of Organization: College or University

Contact Information: Dr. Diane Henshel

School of Public and Environmental Affairs

SPEA 340 10th and Fee Lane

Bloomington IN 47405

Phone: (812) 855 - 4556 **Extension:**

Fax: (812) 855 - 7802

E-Mail: dhenshel@indiana.edu

Project Title: Health Implications of Iron as a Co-contaminant in Sediment

Project Category: Contaminated Sediments

Rank by Organization (if applicable): 0

Total Funding Requested ($): 120,500 **Project Duration:** 2 Years

Abstract:

Priority persistent toxicants in the Great Lakes include both metals and organochlorine compounds, both of which tend to accumulate in sediments. Two of the metals of greatest concern include both mercury (Hg) and lead (Pb). Two of the organochlorine groupings of greatest concern include PCBs and TCDD. All of these co-contaminants induce oxidative stress in target tissues, among their other documented tissue and cellular effects. Iron is another common co-contaminant in high concentrations in sediment in regions with heavy industrailization and mining (as in many of the AOCs in the Great Lakes). Iron is not generally considered toxic for regulatory purposes, yet a vast literature documents the toxicity of iron to tissues prone to oxidative stress damage, such as the heart. Since iron is not considered "toxic", the health implications of high concentrations of iron in sediment, and up the food chain, as a co-contaminant with other inducers of oxidative stress has never been considered. We propose to evaluate the potential for synergistic interactions between all these sediment co-contaminants using blood from bald eagles, one of the ecologically critical and threatened SOLEC indicator species. Using blood collected as part of a 15 - 20 year Michigan-wide monitoring project being funded by the Michigan DEQ, and using the biochemical data already being generated as part of that study, we will measure indicators of oxidative stress (SOD, catalase, Glutathione peroxidase, apoptotic cells,) and iron balance in the plasma and blood cells and correlate this information with the other indicators of exposure and effect measured in the blood of the same eagles. The eagle blood is being collected from areas with spatial gradients of Hg, Pb, PCBs), and Fe, enabling us to evaluate the relative contribution of each contaminant to changes in the oxidative stress indicators. This will improve our ability to assess the relative risks to health due to exposure to sediment.

Geographic Areas Affected by the Project

States:

- ☐ Illinois
- ☐ Indiana
- ☒ Michigan
- ☐ Minnesota
- ☐ New York
- ☐ Pennsylvania
- ☐ Wisconsin
- ☐ Ohio

Lakes:

- ☒ Superior
- ☒ Huron
- ☒ Michigan
- ☐ Erie
- ☐ Ontario
- ☐ All Lakes

Geographic Initiatives:

☐ Greater Chicago ☐ NE Ohio ☐ NW Indiana ☒ SE Michigan ☐ Lake St. Clair

Primary Affected Area of Concern: Clinton River, MI

Other Affected Areas of Concern: All AOCs with high iron co-contaminants in soil, including those with mining and heavy industry nearby.

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Not Applicable

Other Affected Biodiversity Investment Areas:

Problem Statement:

Two primary and two secondary SOLEC indicators are addressed by this proposal:
(Primary) Indicator #8149 Nearshore Protected Areas
(Primary) Indicator #4516 Sediment Flowing into Coastal Wetlands
This proposal will begin to address the potential enhanced toxicity and risk to biota due to the presence of high, bioavailable concentrations of iron as a co-contaminant in sediment with other agents of oxidative stress, such as Pb, Hg, and PCBs.
(Secondary) Indicator #8135 Contaminants Affecting the Productivity of Bald Eagles
(Secondary) Indicator # 8161 Threatened Species
Because we are using bald eagles as the indicator species, the results of this study may contribute to our understanding of the chemical stresses that impact the health and productivity of these and other animals that are in and feed from the aquatic food chain.

A major concern for evaluation of ecosystem and human health risk due to contaminated sediments both in situ and during the remediation or restoration process, is how to evaluate the implications of co-contaminants in the sediments. This data integration is difficult enough when there is data on the isolated contaminants, as exists with the major AOC contaminants of concern (COCs). This data integration is, however, virtually impossible when there is almost no data available, as is the case for iron (Fe). As an essential element, Fe is considered "non-toxic", yet, just like selenium and other essential elements, excess Fe is unquestionably toxic. Further, many of the COCs cause at least one biological effect that is impacted (actually made worse) by iron, the metabolism and production of oxidative radicals. Thus we propose to evaluate the potential for an effects interaction between the common contaminants that show up in sediments where iron is also very high by monitoring the exposure and oxidative stress effects in a co-exposed SOLEC indicator species.

This problem is present in all of the Great Lakes. It is a concern at many of the AOCs, both in Michigan and outside of Michigan (such as in the Grand Calument River/Indiana Harbor AOC. This issue needs to be at least considered, if not directly addressed, by all of the LAMPs, and many of the RAPs.

Proposed Work Outcome:

1. Bloods will be collected and field processed by Dr. Bowerman and his field team.
2. Blood and blood cells will be analyzed for: lead, mercury, free and bound iron (+2, +3), hematocrit, Glutathione peroxidase -reduced and -oxidized, superoxide dismutase, catalase, ALAD (as an indicator of other lead effects), and EROD (as a TCDD-TEQ indicator). We will use Standard Operating Protocols already established by ourselves and others.

3. Data will be analyzed using statistics (a combination of SAS and Excel) to tease out the relative contribution of each contaminant, graphing (Excel and Sigma Plot) to visualize quantitative trends in the data, and GIS to visualize spatial trends in the data.
4. Results will be written up, presented at national and international meetings, written up as a report to GLNPO, and submitted to peer-reviewed journals for publication.

As a result of this project, risk assessors will be better able to determine the human and ecological health risks due to the presence of and remediation of sediments containing iron and certain priority metals (Hg, Pb) as co-contaminants with PCBs.

Project Milestones:	**Dates:**
Project Start	08/2000
Receive Bloods from Field Crew	08/2000
Analyses of Blood Samples completed Yr 1	05/2001
Data analysis / write up completed Yr 1	08/2001
Receive Bloods from Field Crew	08/2001
Analyses of Blood Samples completed Yr 2	05/2001
Data analysis / write up completed Yr 2	08/2001
Project End	08/2002

☒ Project Addresses Environmental Justice

If So, Description of How:

This project addresses environmental justice because it is the low income communities where people tend to live closest to those areas where such co-contaminants exist in the sediments. At this time, the medical community acknowledges that high iron toxicity is a problem, and is contributing to the incidence of heart disease. However, the environmental community ignores the potential for toxic interactions between the high levels of iron and other persistent toxicants (lead, mercury, and PCBs as just an example of a few) that co-exist in the sediment. And yet, as iron is an essential metal, the body favors iron uptake. Thus, fish muscle is likely to be as high in iron as it is high in mercury (both of which store preferentially in muscle). So fish eaters who even try to avoid the more toxic "liver" and (when possible) fat stores are still likely to unknowingly be co-exposed to iron and mercury. This is a serious environmental justice issue, because all too many subsistence fishers continue to eat fish despite fish advisories. In order to properly evaluate the potential risks these fishers are facing, we must be able to evaluate the enhanced risks due to co-exposure to an essential, yet potentially toxic, iron load.

☒ Project Addresses Education/Outreach

If So, Description of How:

The results of this study will be published in peer-reviewed scientific journals and presented at national conferences. When the data is first published, we will write a press release for the lay press and community newsgroup newsletters, including the IJC newsletter, FORUM.

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	20,000	15,000
Fringe:	1,000	3,000
Travel:	2,000	0
Equipment:	0	0
Supplies:	16,000	0
Contracts:	32,000	68,000
Construction:	0	0
Other:	16,500	0
Total Direct Costs:	87,500	86,000
Indirect Costs:	33,000	0
Total:	120,500	86,000
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Dr. Bowerman's project is already funded for 15 - 20 years by the Michigan DEQ ($68,000/year). As this sub-project gets underway, we will seek other funding to enable it to continue, if needed, beyond the initial 2 years.

Description of Collaboration/Community Based Support:

Dr. William Bowerman (the co-P.I.) is under a 15 to 20 year contract with the Michigan Department of Environmental Quality survey Bald Eagles throughout Michigan as holistic indicators of environmental health. The information gathered under the GLNPO project will be shared with the Michigan DEQ. Further, as both Drs. Bowerman and Henshel are members of the IJC Science Advisory Board, there are plans to share the information with the IJC, a summary of which could be posted in Forum (the IJC outreach newsletter). In addition, Dr. Henshel is in the midst of developing a collaboration with the Indiana University - Northwest Environmental Justice Center. Plans include developing a website which will incorporate monitoring and health data in a citizen and scientist-friendly vehicle. A section of this website will include posting of synopses and references to relevant research, a category in which this research would be included.